Presented free
with the
May 1972 issue of
Everyday Electronics

CONSTRUCTORS COMPANION

CONSTRUCTORS COMPANION

CONTENTS

Transistor Circuit Configuration 1

Resistors 2

Capacitors 6

Loudspeakers 10

Relays 11

Soldering 12

Construction Methods 14

Semiconductor Devices 18

TRANSISTOR CIRCUIT CONFIGURATIONS

In the majority of transistor circuits, one terminal of the input is common with the output. Since the transistor has three terminals there are three such arrangements and these are called, the common-emitter, common-base and common-collector, the name of the mode indicating the common terminal.

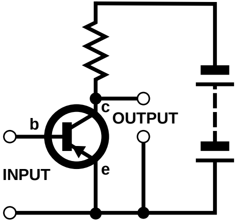
The most usual mode to work with is the common-emitter, since the maximum gain is obtained with this configuration. The other two arrangements each have their own advantages and applications.

The three possible configurations for a single stage a.c. amplifier are shown below,

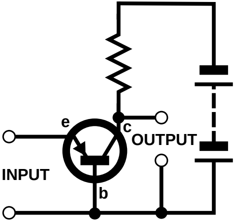
Common emitter: High current gain, high voltage gain, very high power gain. Medium input impedance, high output impedance, low cut-off frequency.

Common base

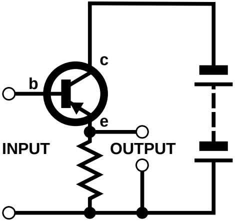
Current gain of unity, low voltage gain, medium power gain. Very low input impedance, very high output impedance, high cut-off frequency.



Common emitter



Common base



Common collector

Parameter	Common emitter	Common base	Common collector
Current gain	High	Unity	High
Voltage gain	High	Low	Unity
Power gain	Very High	Medium	Low
Input impedance	Medium	Low	High
Output impedance	High	Very High	Low
Cut-off Frequency	Low	High	Low

Common collector: High current gain, voltage gain of unity, low power gain. High input impedance, low output impedance, low cut-off frequency.

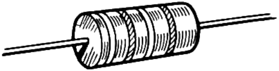
RESISTORS

Basically there are three different kinds of fixed resistor, each described by its composition — (a) carbon (b) metal oxide (c) wire wound.

Carbon

Generally speaking the carbon composition resistor is mainly used in low power consuming circuits, although some high power types are available.

The power handling capabilities of resistors is denoted by its wattage rating which for carbon resistors ranges $^1/_{10}$, $\frac{1}{8}$, $\frac{1}{4}$, $\frac{1}{2}$, 1, 2 watt and higher, the physical size of the resistor increasing with wattage.



The most commonly used are the $\frac{1}{4}$ and $\frac{1}{2}$ watt types, ± 5 and ± 10 per cent being typical tolerances from nominal.

Carbon resistors can be subdivided into two main classes, (1) carbon film (2) moulded carbon, the former being used for their low noise characteristics.

Metal Oxide

The metal oxide type of resistor offers high stability (usually called 'hi-stabs') over a very long time period, typically ±4 per cent for 25,000 hours of operation and are virtually temperature independent over a wide range.

The tolerance of these resistors is usually ±1 and ±2 per cent. Generally they are not for use in high power circuitry having wattage ratings of ½ and 1 watt.

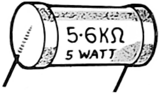
Metal oxide resistors have a very low noise factor typically 0·1μV per volt.

These are more expensive than the carbon types.

Wirewound

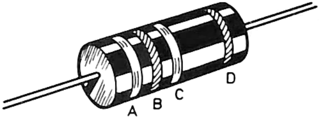
This type of resistor is used where high power is being used or likely to be dissipated.

Power ratings have an extensive range from about 1 watt up to 60 watts or more, with tolerances of ±5 and ±10 per cent.



RESISTOR COLOUR CODE

All carbon resistors use the coded 'band' system to identify their ohmic values and tolerance.



The colour code is given in Table 1 and is used as follows: The four bands A, B, C, and D are displaced towards one end of the resistor. Starting at this end, band A gives the value of the first digit, band B gives the value of the second digit while band C gives the factor for multiplying the first two digits. The fourth band (which in most cases is a metallic one—gold or silver) gives the tolerance from nominal.

Table 1
THE RESISTOR COLOUR CODE

	1st digit	2nd digit	Multiplier	Tolerance per cent
Colour	**A**	**B**	**C**	**D**
Black	1	0	—	—
Brown	1	1	10	± 1
Red	2	2	100	± 2
Orange	3	3	1,000	± 3
Yellow	4	4	10,000	± 4
Green	5	5	100,000	—
Blue	6	6	1,000,000	—
Violet	7	7	10,000,000	—
Grey	8	8	100,000,000	—
White	9	9	1,000,000,000	—
Gold	—	—	0·1	± 5
Silver	—	—	0·01	± 10

The resistor values are in ohms

Examples:

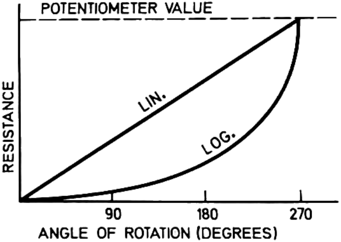
A	**B**	**C**	**D**	**Value**
Orange	Orange	Gold	Gold	3·3Ω ± 5%
Blue	Grey	Red	Silver	6·8KΩ ± 10%

Variable resistors—Potentiometers

Potentiometers are available in two types, carbon and wirewound, the latter being used where high power is being employed. Carbon types are available with a logarithmic (log.) and linear (lin.) resistance relationship with angle of rotation.

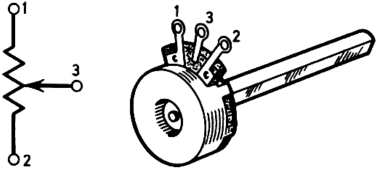
The angle of rotation is usually limited to about 270 degrees.

The lin. type is used where it is required to vary the resistance in direct proportion to the angle of rotation whereas the log. type is normally found at the output of audio equipment such as volume controls.



Carbon potentiometers have an extensive range of values, approximately 1 kilohm to about 2 megohm. The wirewound range is approximately 10 ohm to 100 kilohm.

Both types have their values printed on the body of the potentiometer and wirewound types usually have their wattage ratings also, e.g. 5kΩ 1W.



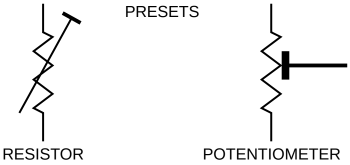
It has three terminals, and being used as a potential divider for example, the input voltage is applied to tags 1 and 2 and taken out from tag 3, the wiper, and one of the others. Thus any potential from zero to that across tags 1 and 2 can be obtained.

A potentiometer can be used as a variable resistor by merely using the wiper with one of the other tags, 1 or 2.

Some potentiometers have an on/off switch incorporated.

Preset

Another type of potentiometer or variable resistor is the pre-set, either carbon or wirewound. These have a specific appli-



cation such as in a circuit where a fixed value resistor or potentiometer is called for, but cannot be accurately specified.

CAPACITORS

Generally speaking, capacitors are divided into three major categories:

(a) electrolytic
(b) non-electrolytic
(c) variable

Normally, capacitors have their values printed on their bodies, together with the 'working voltage'. This voltage is the maximum that should ever be applied to the capacitor; if it is exceeded the capacitor may be destroyed and cause other parts of the circuit to be destroyed also.

When a particular capacitor is specified with its working voltage, it is not essential in most cases to use that exact value (since the tolerance of capacitors is quite substantial) but it is essential to use one of at least the required working voltage.

Capacitors of a higher working voltage can be used but a 'rule of thumb' is to keep the working voltage between that specified and four times this amount.

Electrolytic

These capacitors come in a variety of shapes and sizes and are polarity conscious, that is to say, they have a negative and positive terminal and must be connected in the circuit the right way round.

Usually the positive lead is marked on the body with a plus sign +, red or black band or red or black end-face. Alternatively, the negative end is marked with a minus sign (−).

Electrolytic capacitors are chiefly used where high values of capacitance are required since with this type high values ranging up to 20,000μF can be contained in a relatively small physical size. Tolerances are within −25 to +100 per cent.

Non-electrolytic

In this category there are several different kinds each with their own particular application, although it is rarely critical to employ a specific type except where tolerance and leakage are important parameters such as in timing circuits, etc.

These various types are subdivided into classes, each class being named after the dielectric constituent.

Silver mica, Polystyrene and Ceramic capacitors as seen from Table 3 have relatively low capacitance values ranging up to 10,000pF (0·01μF). The first two, having low tolerance figures are used in circuits where they are the controlling parameters, especially in the case of silver mica since they are very stable they are used for radio receiver aerial circuitry.

Ceramic types however are very sensitive to temperature change and are sometimes employed where this characteristic is advantageous.

By far the most commonly used type is the **Polyester**, probably due to its low cost and capacitance range.

As far as the amateur is concerned the **Polycarbonate** type has the same adaptability as the polyester capacitors but with an extended range. They are a little more expensive than the polyester.

Tantalum capacitors, a fairly new type on the amateur scene and now inexpensive, have a very wide range of values and a very low leakage figure. They are usually employed in circuits where this is a vital factor—such as timing circuits. Very stable, low tolerance.

Variable

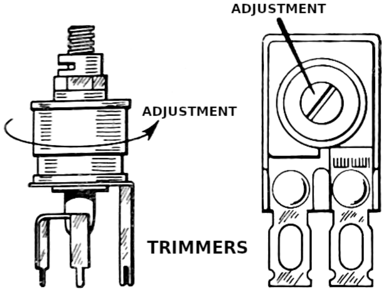
These can be divided into two distinct types, (1) continuously variable (2) preset.

Type (1) are designed primarily for use in radio tuning circuits and therefore have values up to 500pF to deal with radio frequencies (R.F.).

The most common types use air as the dielectric and their values are made continuously variable by rotating a set of moveable vanes interleaving a fixed set. This rotation varies the effective area of the capacitor ‘plate’ thereby changing the capacitance.

Some smaller types, as used in portable transistor radios, have the vanes or plates closer together (to increase the capacity) with a flexible solid plastic dielectric in between to keep the plates apart and again increasing the capacitance.

Type (2) are more commonly called ‘trimmers’ and are analagous in use to the preset potentiometers. These have very low values up to about 150pF.



TRIMMERS

CONCENTRIC

COMPRESSION

Table 2
COMPARISON OF SOME COMMON-CAPACITOR PARAMETERS

Type (Dielectric)	**Capacitance range available**	**Working voltage (Volts)**	**Tolerance per cent**
Silver mica	1–10,000pF	Typically 300	±1, ±2
Polystyrene	10–10,000pF	30–500	±2, ±10
Ceramic	50–10,000pF	30–500	±20
Polyester	0·01–1µF	50–300	±20
Polycarbonate	0·01–5µF	50–600	±20
Tantalum	0·02–270µF	6–100	±20
Electrolytic	1–20,000µF	10–600	−25 to +100

C280 SERIES CAPACITOR COLOUR CODE

A new colour code has recently been introduced on the Mullard C280 series metallised polyester capacitors which is becoming very popular with the amateur.

It consists of five coloured horizontal bands, labelled A, B, C, D, and E and its value is determined by using Table 3.

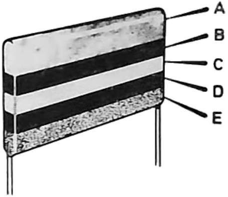


Table 3
THE C280 SERIES CAPACITOR COLOUR CODE

Colour	1st digit A	2nd digit B	Multiplier C	Tolerance per cent D	Working voltage V. E
Black	—	0	1	±20	—
Brown	1	1	10	—	—
Red	2	2	100	—	250
Orange	3	3	1,000	—	—
Yellow	4	4	10,000	—	400
Green	5	5	100,000	—	—
Blue	6	6	1,000,000	—	—
Violet	7	7	10,000,000	—	—
Grey	8	8	100,000,000	—	—
White	9	9	1,000,000,000	±10	—

The A band gives the value of the first digit, band B gives the second digit, and C band the multiplying factor. The fourth band, which is either black or white, gives the tolerance from nominal. The last band E, gives the working voltage.

The value is in picofarads (pF).

LOUDSPEAKERS

Loudspeakers come in a variety of sizes and values. Impedance values commonly available are 3, 5, 7·5, 8, 15, 35, 75, and 140 ohms. This value is the a.c. resistance, measured at about 470Hz.

Where a particular impedance is specified in a circuit, this has been done for matching purposes, i.e. for maximum power transfer with minimum distortion.

Using one with a value lower than that specified may, especially in the case of transistor devices, over run the transistor in the output stage and destroy it. It will also be mis-matched and may produce more distortion.

In general, using a value above that specified will not do any harm to the circuit but the power output will be greatly reduced and distortion will occur.

Loudspeakers always have their impedance value printed somewhere on the body. Only hi-fi loudspeakers generally have the power rating printed as well.

Loudspeakers are specified by their impedance and either a wattage rating or diameter of the speaker cone, e.g. 15Ω 20W, 3½ inch 35Ω.

It is a good idea to use a value close to that recommended for a particular device, but there is no reason why a higher power rating (or larger cone diameter) type cannot be used, provided it has the same impedance. *Never* use a lower power type than that specified otherwise its lifetime will be seriously reduced.

EARPIECES

The same applies to earpieces as with loudspeakers above.

There are several types available, crystal, magnetic and dynamic, all of which are less efficient than loudspeakers.

Earpieces have a very low bass response

characteristic as well as a low frequency cut-off point.

Typical impedances range from 8-250 ohm. Generally, earpieces are characterised by low cost, but poor quality in comparison with loudspeakers.

RELAYS

There are many different types of relay available varying in all parameters such as size, weight, shape, number of contacts, working voltage, operational current, coil resistance, operate/release times, contact ratings (low, medium and high power types) and basic mode of operation.

The amateur constructor should however be familiar with the two types specified below.

G.P.O. types

There are two common Post Office Types called the 600 type and the 3,000 type. They are made in different sizes, shapes and number of contacts; and are available with a wide range of coil resistances.

Coils can be readily interchanged so the required coil resistance can be obtained.

They have up to nine change-over contacts, having operate/release times between 15 and 40 milliseconds.

The contacts can be adjusted to make—before—break or vice versa—or a combination of both using two or more contacts.

The relay sensitivity can be adjusted down to a power rating of 15mW.

This type of relay is readily available both new and secondhand at low cost.

Reed relay

Due to its small size and weight and high sensitivity, the reed type of relay is becoming more and more popular with the amateur constructor.

The relay is made up of two parts, a glass encapsulated reed switch and a solenoid.

The reed switch is merely a pair of open (or closed) contacts encapsulated in an inert atmosphere in a glass tube. The reed tips are magnetic (like poles for open types—unlike poles for closed types).

The switch is placed inside the solenoid and when sufficiently energised the magnetic field produced by the coil overcomes the force of attraction (or repulsion) between the reed poles and causes it to switch ‘in’ (or out).

Reed relays have very fast ‘switch-on’ times—typically 2 milliseconds, with even faster ‘switch-off’ times.

Maximum current flow through the switch is about 2 amperes but this varies with types.

Coils for operating the reed switches can be purchased or wound as desired. More expensive than the G.P.O. type.

Important points to consider when selecting a relay for a particular application are, operating voltage, current required for ‘switch-on’, coil resistance, and whether the relay contacts are designed to withstand the current passing through them and, when being ‘switched-on’ by a pulse, the operating time.

Selection should be made with the aid of manufacturers characteristics often given in component catalogues.

SOLDERING

There is an art to soldering that can be accomplished by some basic exercises and practice provided you have the right tools and a good idea of the method used. A small 15 to 25 watt electric soldering iron with a $^{3}/_{16}$ in or $\frac{1}{4}$ in angle faced bit (see Fig. 1) and some 18 or 22 s.w.g. resin flux cored solder are the basic requirements. A small pair of tapered nose pliers and side cutters are the other main tools.

Instead of just describing how to make a joint we are going to describe an exercise in basic soldering. You will need the tools described above, a reel of 18 s.w.g. tinned copper wire and a block of balsa wood measuring about 6 inches by 4 inches by $\frac{1}{4}$ inch, or more thick.

Take a length of wire (about 3 feet long) and straighten it by holding each end and stretching it slightly—use the pliers and a vice to hold the wire. Cut two 6 inch lengths of the straightened wire, bend each end at

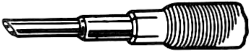


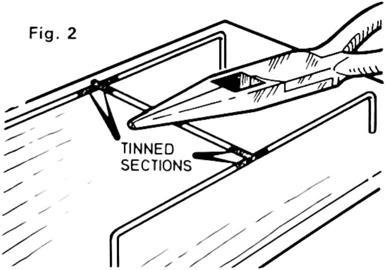
Fig. 1

right angles $\frac{3}{4}$ inch from the ends and push into the balsa wood (Fig. 2).

Plug in the iron, making sure that the bit is clean first—if it is pitted carefully file the end until smooth copper shows—when the iron is hot melt some of the solder onto the bit face thus tinning the bit.

Use the iron to tin the wires on the balsa wood. Hold the bit under one wire near the bend and apply a small amount of solder to the wire. Make sure that the solder runs freely over the wire and when it cools remains smooth and shiny; this retinning makes sure that the joint will be a good one. Tin each wire in about three positions—making the positions on each wire opposite.

Fig. 2



Cut three more wires just long enough to cross the two wires in the wood and tin each end of these pieces. Lay one wire across the two supported wires on a tinned section, laying pliers on this wire to hold it (Fig. 2). Retin the bit and hold it under the joint against the supported wire. Next place some solder on the joint so that it runs around the wires freely.

Remove the iron by sliding it upwards against the wire leaving a clean shiny joint (Fig. 3). If the solder has not completely run into the joint repeat the above from: 'Retin the'. Avoid using too much solder so that a blob is formed under the supported wire.

If the solder is not shiny when it cools you have made a dry joint, usually caused by keeping the iron on the joint too long and burning off the flux or moving joint before it has cooled. Practice making joints using the other: wires to make a ladder, remove the finished article inspect the joints and test them for strength.

Repeat this until you can achieve good joints all the time. Try soldering another wire down the centre of the ladder, making cross joints. Practise this until you are proficient, and you will have mastered the basics of soldering.

To go a step further try joining a piece of covered connecting wire to a piece of tinned copper wire. Strip about ¼ inch of the insulation off, tin the end, wrap it around the tinned copper wire and solder the joint. Eventually you should be able to do this without burning the plastic insulation.

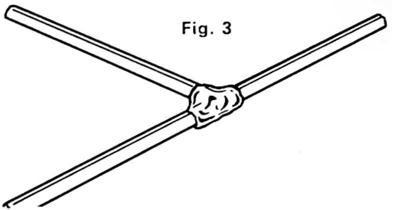


Fig. 3

CONSTRUCTIONAL METHODS

Veroboard

Veroboard is basically an s.r.b.p. (synthetic resin bonded paper) sheet with holes drilled through it in a matrix. Veroboard is available in three basic types—plain, with copper strips on one side connecting the holes in rows, and in the form of Verostrip with copper strips connecting a few holes on each side of the board (Fig. 1).

The three basic types are also available in three different matrix sizes 0·1in, 0·15in and 0·2in. The 0·15in being the most popular for the amateur construction, the 0·2 inch matrix not being in great supply. Veropins can be used with all types and matrix sizes, these pins are inserted through the holes in the board as required. A spot face cutter can be used with the standard Veroboard (with copper strips) to cut the strips where required, this can also be done using a $^3/_{16}$ in or ¼ in drill held in the hand.

The main advantages of Veroboard are

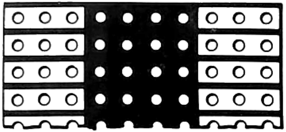


Fig. 1

that the wiring is 'printed' on one side in the form of the copper strips and the components are rigidly mounted by passing their leads through the holes and soldering them to the copper strips (Fig. 2). The Verostrip can be used for mounting a number of components—such as resistors—that are connected by wires to a remote switch or other components.

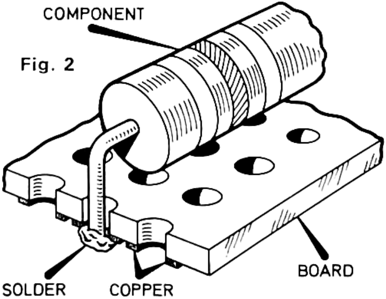


Fig. 2

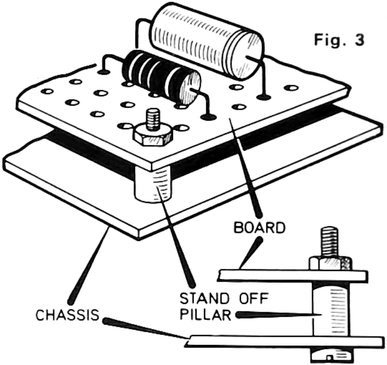


Fig. 3

Plain board will hold the components in a similar manner to the board with copper strips but the components must be wired up using 18 or 22 s.w.g. tinned copper wire or single strand p.v.c. covered connecting wire.

Veropins are very useful with the plain board as they form good anchorage for large components and for flying leads to other components.

In general all types of Veroboard can be mounted by cutting larger holes through the board, cutting away the copper strips around the holes where necessary to prevent any shorting and fixing the board to the chassis or case of the unit under construction using spacers, 4B.A. screws and nuts (Fig. 3).

Printed Circuit

Printed circuit board is basically copper clad s.r.b.p. or fibreglass board. The copper is chemically etched away to form a pattern used to inter-connect the electronic components. Once the board has been etched holes are drilled through the board and remaining copper in the positions determined for fixing the components (Fig. 4). The components are then mounted by passing their leads through the holes and soldering them to the copper on the other side.

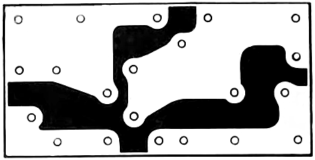


Fig. 4

Printed circuit is very versatile and perhaps the neatest and most reliable of the electronic constructional methods, although it is more suitable for production runs than for amateur constructers ‘one off’ projects.

Printed circuit boards are sometimes available for published designs from various ‘kit’ firms or component suppliers. Often the board is available in two types s.r.b.p. backing and fibreglass backing. Of these two fibreglass is the best as it is less affected by heat and moisture, however s.r.b.p. is quite suitable for most amateur projects—some car projects that could be subjected to excess temperature variations, and moisture can be built on fibreglass board as a preference.

The circuit board can be mounted to the

case or chassis in a similar manner to Veroboard and pins or tag post, can be used for connecting flying leads to the board.

Universal Printed Circuits

Various types of ‘universal printed circuits’ are available. These consist of a printed circuit board with a special pattern etched into the copper. The pattern has been designed so that as many different circuits can be constructed on one board as possible. These circuit boards may or may not be pre-drilled.

Tagboard

Tagboards are generally available in two types, double and single tags, the first being an s.r.b.p. panel approximately 2 inches wide with tags opposite each other along the sides (Fig 5), single tag strip is normally a thin s.r.b.p. strip on which are mounted a number of tags (Fig. 6).

Both types are generally only used for projects with a limited number of components since neither form can neatly house large numbers of components. The ‘double’ tag strip can be used to mount components across the opposite tags or between adjacent tags. Wiring connecting various tags can be accommodated under the tagboard (Fig. 5). The single tagstrip is used for mounting a few components or for providing a connection point for wires in a unit.

‘Double’ tagstrip can be mounted in a similar way to Veroboard, using spacers to prevent shorting.

Fig. 5

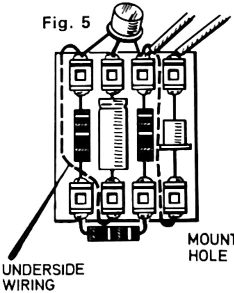
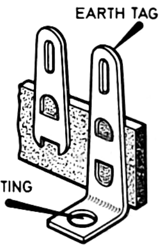


Fig. 6

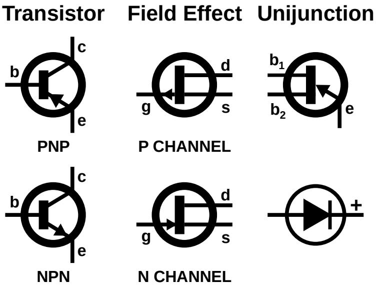


SEMICONDUCTOR DEVICES

The following pages give brief data on a selection of various semiconductor devices.

Transistors are classified under low or high power (up to 1W and above 1W) and their suitability for switching applications. Field effect transistors, unijunctions, and small signal diodes are under separate headings.

Zener diodes, rectifier diodes and controlled rectifiers are not included in this list as they are now generally sold to private constructors under their ratings and often no type numbers are quoted. Integrated circuit data has not been included.



The data given is under the following abbreviations:

Type p. *pnp* (or p. channel), n. *npn* (or n. channel), s. silicon, g. germanium.

Base The base type is numbered and diagrams appear on inside back cover.

$V_{ceo\,max}$ Maximum collector-emitter voltage (in volts) with base open circuit.

V_{cbo} (collector-base voltage) generally has a similar value but where the two differ V_{ceo} is lower.

$I_{c\,max}$ mA Maximum collector current in milliamps (except where stated).

$H_{fe\,typ}$ Typical small signal current gain.

$P_{t\,max}$ mW Maximum total power dissipation in milliwatts (except where stated).

Sub. In some cases a similar device has been listed as a substitute. Such devices can be substituted in most cases but are not necessarily direct equivalents.

$V_{\mathbf{gss}\mathrm{max}}$ Maximum gate to source voltage, drain shorted to source.

$I_{\mathbf{dss}\mathrm{max}}$ mA Maximum drain to source current, gate shorted to source.

$g_{\mathbf{m}\mathrm{typ}}$ mmho Typical transconductance (small change in drain current divided by small change in gate to source voltage) in millimhos.

$P_{\mathbf{t}}$ mW Total power dissipation in milliwatts.

$V_{\mathbf{b1b2}\mathrm{max}}$ Maximum base 1 to base 2 voltage.

$I_{\mathbf{e}\mathrm{max}}$ mA Maximum emitter current in milliamps.

P.I.V. Peak inverse voltage.

$I_{\mathbf{f}\mathrm{max}}$ mA Maximum continuous forward current.

$I_{\mathbf{f}\mathrm{surge}}$ mA Maximum surge current for 1 second.

SMALL SIGNAL DIODES

Device	Type	P.I.V.	$I_{\mathbf{fmax}}$ mA	$I_{\mathbf{fsurge}}$ mA
IN914	s.	75	110	225
IN916	s.	75	100	225
IN4148	s.	75	225	400
OA81	g.	115	50	150
OA91	g.	115	50	150
OA200	s.	50	160	250
OA202	s.	150	160	250
ZS140	s.	15	250	1·5A
ZS170	s.	50	750	5A

TRANSISTORS

Suitable for Switching

Device	Type	Base	$V_{ceo\,max}$	$I_{c\,max}$ mA	$h_{fe\,typ}$	$P_{c\,max}$ mW	Sub.
2N696	n.s.	1	40	500	40	600	
2N697	n.s.	1	40	500	70	600	2N2102
2N1091	n.g.	1	12	400	70	120	NKTI25
2S503	n.s.	3	25	30	180	300	
ACY22	p.g.	1	15	1A	200	160	NKT261
ACY40	p.g	1	18	500	45	260	NKT244
ACY41	p.g.	1	18	500	90	260	NKT245
ASY26	p.g.	1	25	300	15	150	2N1303
ASY27	p.g.	1	20	200	20	150	
BSY27	n.s.	1	15	100	55	300	
BSY29	n.s.	1	12	100	54	300	
NKT124	p.g.	2	20	500	150	75	
NKT125	p.g.	2	20	500	100	75	
NKT126	p.g.	2	20	500	75	75	2N1703
TIS45	n.s.	5	15	200	15	250	
			Low Power				
2G302	p.g.	7	10	200	60	150	NKT125
2G306	p.g.	7	15	200	160	75	NKT124
2G309	p.g.	7	20	100	170	200	ASY55
2N706	n.s.	1	20	50	40	300	

Device	**Type**	**Base**	$V_{ceo\max}$	$I_{c\max}$ mA	$h_{fe\,typ}$	$P_{c\max}$ mW	**Sub.**
2N708	n.s.	1	15		30	360	
2N918	n.s.	3	15	50	50	200	
2N1305	p.g.	1	20	300	130	150	NKT125
2N1307	p.g.	1	15	300	150	150	NKT124
2N1309	p.g.	1	15	300	190	150	NKT124
2N1507	n.s.	1	25	500	150	600	2N2102
2N1613	n.s.	1	40	500	70	800	2N2102
2N2926G	n.s.	4	18	100	400	200	
Y	n.s.	4	18	100	250	200	
O	n.s.	4	18	100	150	200	
2N3702	p.s.	5	25	200	60	360	
2N3703	p.s.	5	30	200	30	360	
2N3706	n.s.	5	20	800	600	360	
2N3707	n.s.	5	30	30	350	360	
2N3709	n.s.	5	30	30	45	360	
2N4058	p.s.	5	30	30	100	360	
2N4060	p.s.	5	30	30	45	360	
2N4061	p.s.	5	30	30	90	360	
2S005	n.s.	1	40	20	80	125	2N338
2S502	n.s.	1	25	30	100	300	
AC107	p.g.	6	15	5	100	50	NKT216
AC126	p.g.	2	32	100	140	500	
AC127	p.g.	2	32	200	100	280	
AC154	p.g.	2	16	500	80	200	NKT271

Device	**Type**	**Base**	V_{ceo}max	$I_c$max mA	h_{fe}typ	$P_c$max mW	**Sub.**
AC187	n.g.	2	15	1A	200	800	
AC188	p.g.	8	15	1A	165	800	
ACY20	p.g.	1	20	1A	60	240	NKT221
ACY44	p.g.	1	30	500	60	260	
AF114	p.g.	9	32	10	150	75	NKT674
AF115	p.g.	9	20	10	150	75	NKT675
AF118	p.g.	9	50	30	180	250	NKT678
AF124	p.g.	10	32	10	140	60	NKT674
AF126	p.g.	10	20	10	140	60	NKT676
AF139	p.g.	3	15	8	50	60	
BC107	n.s.	1	32	100	400	300	
BC108	n.s.	1	20	100	300	300	
BC109	n.s.	1	20	100	600	300	
BC147	n.s.	11	45	100	330	220	
BC169	n.s.	5	20	100	330	180	
BC182	n.s.	1	50	200	480	300	
BC183	n.s.	1	30	200	850	300	
BC184L	n.s.	5	30	200	250	300	
BFY50	n.s.	1	80	1A	45	800	
BFY51	n.s.	1	60	1A	60	800	
C424	n.s.	2	30		50	300	
C425	n.s.	1	60		75	300	
C762	n.s.	1	25	150	110	400	
NKT212	p.g.	2	32	125	60	200	2G303

Device	**Type**	**Base**	$V_{ceo\mathrm{max}}$	$I_{c\mathrm{max}}$ mA	$h_{fe\mathrm{typ}}$	$P_{c\mathrm{max}}$ mW	**Sub.**
NKT213	p.g.	2	32	125	90	200	2G374
NKT214	p.g.	2	32	125	50	200	2G371
NKT271	p.g.	2	15	500	150	200	2G377
NKT274	p.g.	2	15	125	150	200	
NKT275	p.g.	2	15	125	70	200	2G371
OC44	p.g.	6	10	10	100	75	NKT141
OC45	p.g.	6	10	10	40	75	ASY54
OC71	p.g.	6	20	10	47	75	AC155
OC72	p.g.	6	16	125	50	125	AC135
OC81	p.g.	6	15	200		300	AC154
OC139	n.g.	6	20	250	40	140	2N1302
OC140	n.g.	6	20	400	75	140	2N1304
OC171	p.g.	9	20	10	100	60	NKT613
OC200	p.s.	6	25	50	20	250	2S302
OC202	p.s.	6	15	50	70	250	2S302
ZTX108	n.s.	13	25	200	over 75	350	
ZTX300	n.s.	13	25	200	50	350	
ZTX301	n.s.	13	45	200	50	350	
ZTX500	p.s.	13	25	500	50	350	
ZTX501	p.s.	13	45	500	50	350	
ZTX510	p.s.	13	25	500	50	350	

High Power

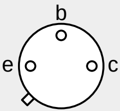
Device	**Type**	**Base**	$V_{ceo\text{max}}$	$I_{c\text{max}}$ mA	$h_{fe\text{typ}}$	$P_{c\text{max}}$ mW	**Sub.**
2N3055	n.s.	12	70	15A	50	115W	
2N3054	n.s.	12	60	4A	100	25W	
AD161	n.g.	12	20	1A	200	4W	
AD162	p.g.	12	20	3A	200	6W	
OC20	p.g.	12	75	8A	50	30W	
OC22	p.g.	12	24	1A	180	15W	2N1907
OC24	p.g.	12	24	1A	180	15W	2N1907
OC26	p.g.	12	16	3·5A	35	12W	NKT452
OC35	p.g.	12	32	10A	50	30W	2N456
OC36	p.g.	12	32	10A	80	30W	2N457

FIELD EFFECT TRANSISTORS

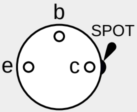
Device	**Type**	**Base**	$V_{gss\text{max}}$	$I_{dss\text{max}}$ mA	$g_{m\text{typ}}$ mmho	P_t mW
2N3819	n.s.	5(1s.2g.3d.)	25	20	4	360
2N3820	p.s.	5(1s.2g.3d.)	20	15	4	360
2N3823	n.s.	3,5(1s.2g.3d)	30	20	5	300
MPF102	n.s.	5(1d.2s.3g.)	25	20	5	200
MPF105	n.s.	5(1d.2s.3g.)	25	20	4	200

UNIJUNCTION TRANSISTORS

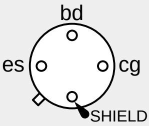
Device	**Type**	**Base**	$V_{b1b2\text{max}}$	$I_{e\text{max}}$ mA	P_t mW
2N1671B	s.	14	35	50	450
2N2160	s.	14	35	70	450
2N2646	s.	14	35	50	300
TIS43	s.	5	35	50	300



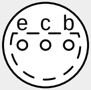
①



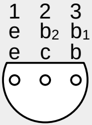
②



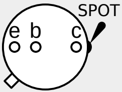
③



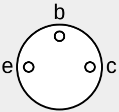
④



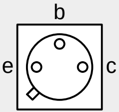
⑤



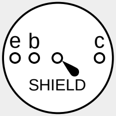
⑥



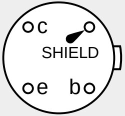
⑦



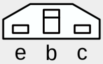
⑧



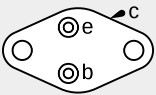
⑨



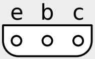
⑩



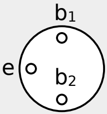
⑪



⑫



⑬



⑭

e = EMITTER
b = BASE
c = COLLECTOR
s = SOURCE
d = DRAIN
g = GATE

© 1972 IPC Magazines Ltd.